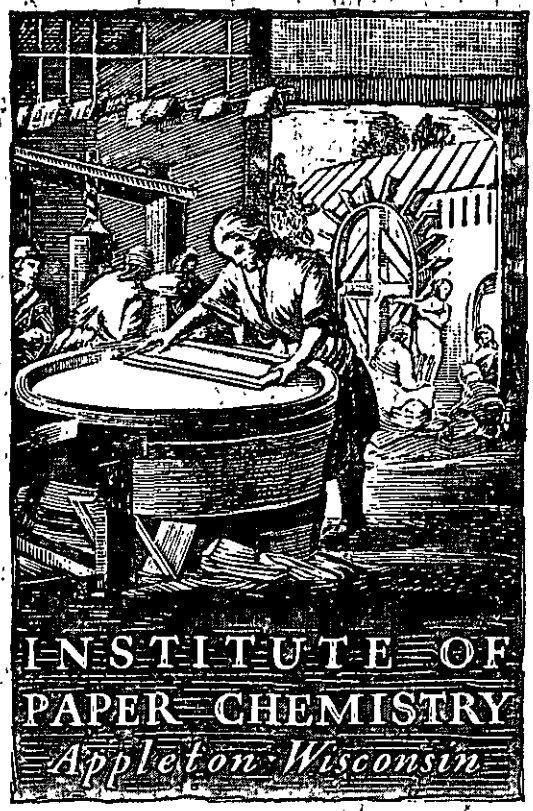

CONTINUOUS EVALUATION OF CORRUGATING MEDIUM

Project 1108-17

Progress Report Two

to

FOURDRINIER KRAFT BOARD INSTITUTE, INC.

December 1, 1955

THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

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CONTINUOUS EVALUATION OF CORRUGATING MEDIUM

The purpose of this study is to provide a continuous evaluation of the quality and runability of corrugating medium produced by members of the Fourdrinier Kraft Board Institute. The study, as it progresses, will accumulate a backlog of data and experience which will provide two important benefits. First, it will enable each participant to evaluate his position in relation to the rest of the industry. Second, it will provide information essential for the interpretation of any proposed specifications on corrugating medium (on either a company or industry basis).

The procedure for participating in this study involves the submission of two rolls of corrugating medium per week for each machine to The Institute of Paper Chemistry. These rolls are taken from regular production runs on <u>different</u> days. Each roll is 10 to 12 inches wide and contains approximately 2,500 lineal feet of medium (approximately 20 inches in diameter). Each roll as it is received by the Institute is assigned a code letter and number. The rolls are numbered in the sequence in which they are received. Code letters are assigned on the basis of machines and a given machine is assigned a different code letter each month in order to mask the identity of the mills. For purposes of reference, a copy of the outline of the program together with the necessary instructions for sampling is appended to this report.

During the month of November, sixty different sample lots of corrugating medium were submitted from the production of thirteen machines to The Institute of Paper Chemistry for evaluation. A tabulation of the samples classified according to machines may be seen in Table I.

TABLE I

DISTRIBUTION OF CORRUGATING MEDIUM SAMPLES

Machine Code	Number of Samples
A	5
B	8
C	1
D	1
E	1
F	2
G	1
H	8
I	7
J	2
K	8
L	8
M	8
Total	60

Each sample of corrugating medium was evaluated for basis weight, caliper, Concora medium test, M. and D. flat crush (single-faced board), and runability. Runability was measured by corrugating each roll under standardized conditions on the Institute's corrugator into A-flute board at 450 feet per minute. If unsatisfactory runability occurred at thhs speed, the corrugator was slowed down in increments of 25 f.p.m. until satisfactory runability was obtained (no ruptured flutes). As indicated above, flat crush was determined on the combined board, thereby providing data which may be useful in studying the relationship between the Concora medium test and combined board flat crush for each participant's medium.

The average test results obtained on the samples of corrugating medium submitted by each participant during November are shown in Table II and graphically presented in Figures 1 to 4. In addition to a comparison of the test data among the various mills, Table II also presents the current F.K.I. averages, cumulative F.K.I. averages, and the F.K.I. indexes. The current F.K.I. average is the average test result for all machines participating in the study during a given month. The cumulative F.K.I. average is based on the results for the previous months excluding the result for the current period. The F.K.I. index is obtained as follows:

$$\frac{\text{current F.K.I. average}}{\text{cumulative F.K.I. average}} \times 100 = \text{F.K.I. index (\%)}$$

The F.K.I. index provides a ready means of comparing the current quality with previous results. An index greater than 100% indicates that current quality is higher than the average result for the previous periods; an index below 100% indicates that current quality is lower than the average result for the previous periods.

The test results obtained on the sample lots submitted from the production of each of the machines are shown in Tables III through XV for A through M, respectively. The average test results obtained on each sample lot are shown; in addition, the over-all average result for all the sample lots submitted for each machine is shown for each test. The latter over-all averages are reported as "current machine averages." A cumulative machine average is also shown and is calculated by averaging the current machine averages for the previous periods (excluding the current period). Also shown for each machine in Tables III to XV are the machine factor and machine index. These factors are defined as follows:

$$\frac{\text{current machine average}}{\text{cumulative machine average}} \times 100 = \text{machine factor (\%)}$$

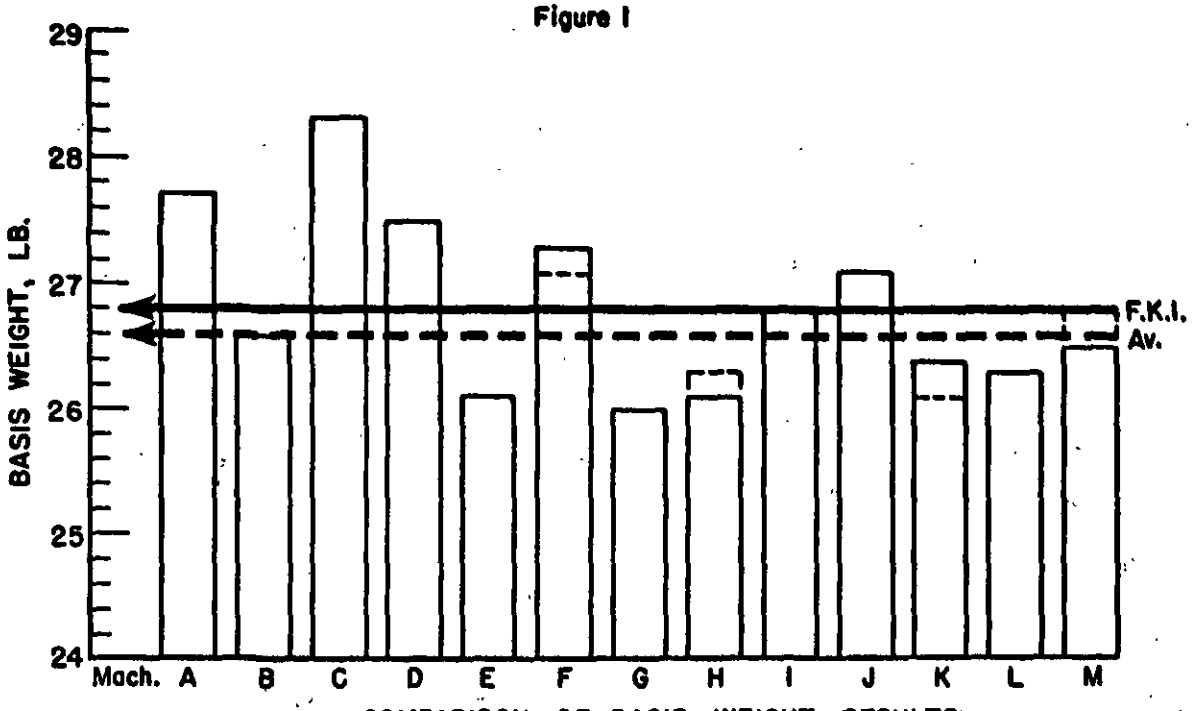
TABLE II

SUMMARY OF CURRENT MACHINE AVERAGES

November, 1955

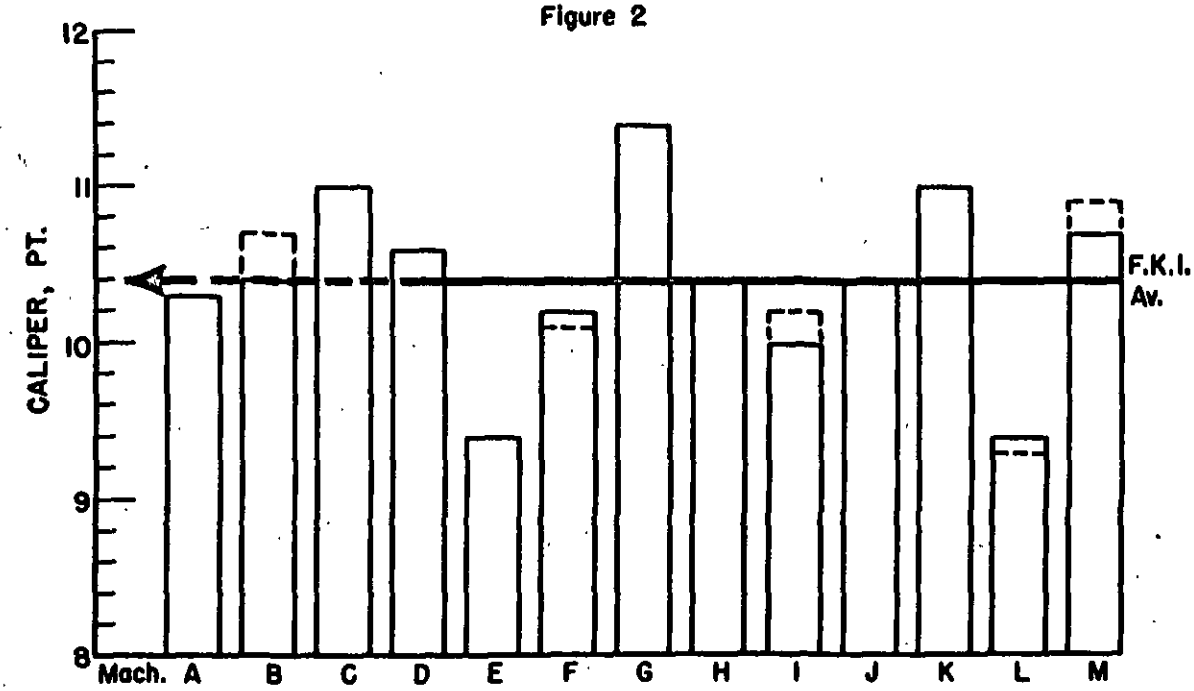
Code	Basis Weight, lb.	Caliper, points	Concora Medium Test, p.s.i.	Single-Face Flat Crush, p.s.i.
A	27.7	10.3	23.6	27.4
B	26.6	10.4	27.0	32.6
C	28.3	11.0	22.7	25.4
D	27.5	10.6	24.5	31.5
E	26.1	9.4	24.9	32.4
F	27.3	10.2	26.4	34.8
G	26.0	11.4	28.0	35.2
H	26.1	10.4	25.9	31.1
I	26.8	10.0	27.7	35.2
J	27.1	10.4	29.3	36.2
K	26.4	11.0	25.4	31.1
L	26.3	9.4	25.9	32.7
M	26.5	10.7	28.7	35.7
Current F.K.I. Average	26.8	10.4	26.2	32.4
Cumulative F.K.I. Average	26.6	10.4	27.4	33.0
F.K.I. Index, %	101.0	100.0	95.4	98.1

Figure 1



COMPARISON OF BASIS WEIGHT RESULTS
November, 1955

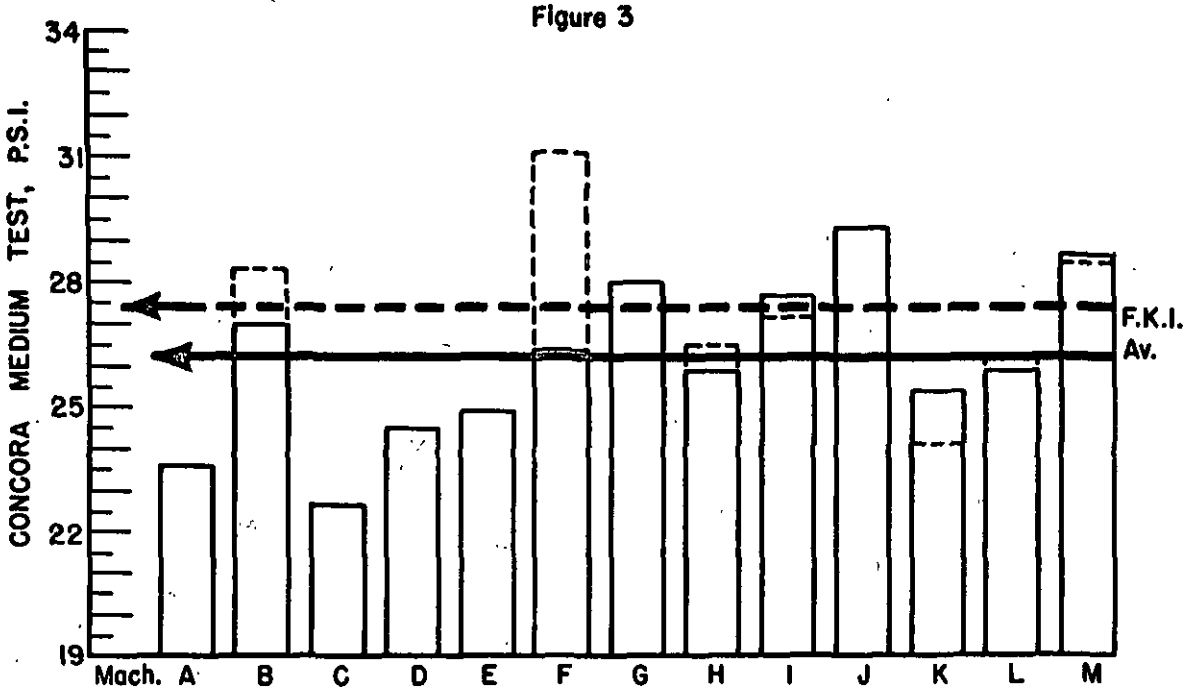
Figure 2



COMPARISON OF CALIPER RESULTS
November, 1955

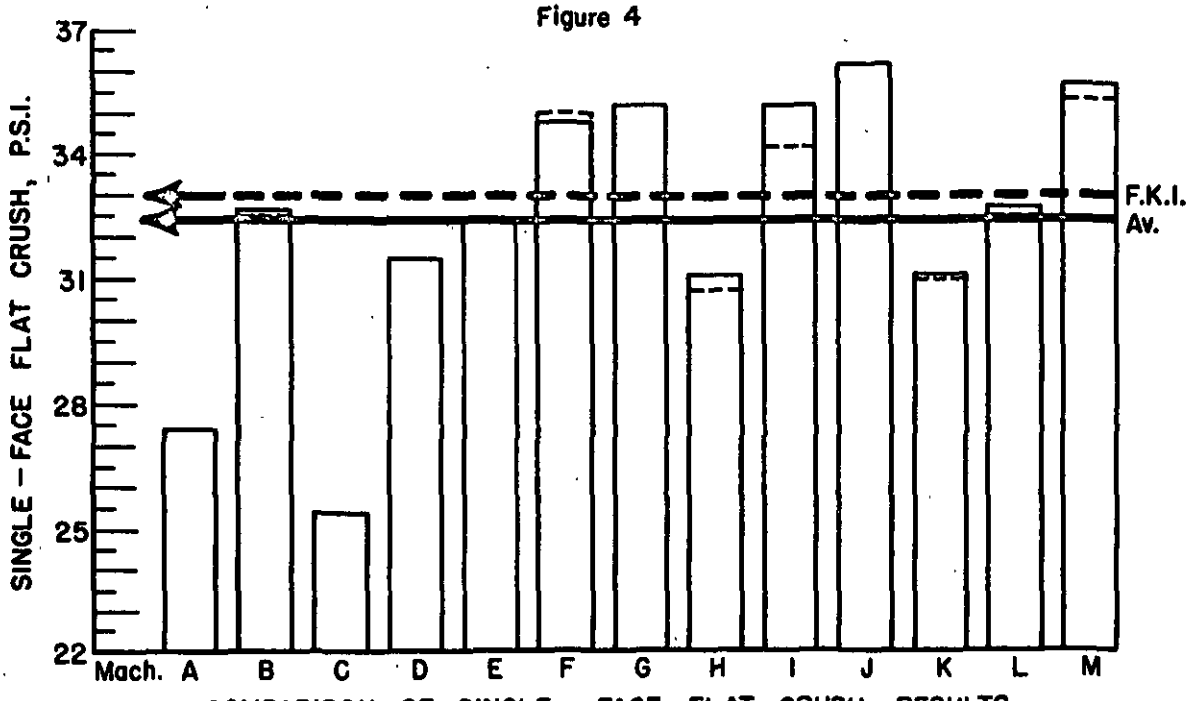
——— Current machine average
- - - - - Cumulative machine average

Figure 3



COMPARISON OF CONCORA MEDIUM TEST RESULTS
November, 1955

Figure 4



COMPARISON OF SINGLE – FACE FLAT CRUSH RESULTS
November, 1955

——— Current machine average
– – – – – Cumulative machine average

$$\frac{\text{current machine average}}{\text{cumulative F.K.I. average}} \times 100 = \text{machine index (\%)}$$

The machine factor and machine index provide a means for comparing the current machine averages with either the previous results for that particular machine or with the cumulative results for all machines--i.e., the cumulative F.K.I. average.

In Table II the current machine averages for the month of November are summarized. It may be noted that basis weight varied from a low of 26.0 for Machine G to a high of 28.3 for Machine C. The average for the thirteen participating machines (current F.K.I. average) was 26.8 lb. per 1000 sq. ft. slightly higher than the cumulative F.K.I. average of 26.6 as indicated by the F.K.I. index of 101.0%. The results for all machines satisfy the requirements of Rule 41.

Caliper results varied from a low value of 9.4 for Machines E and L to a high value of 11.4 for Machine G. The current F.K.I. average for caliper was 10.4 points the same as the cumulative F.K.I. average; thus the F.K.I. index was 100.0%. The caliper results for all mills meet Rule 41 specification.

Flat crush based on the Concora test results ranged from a minimum of 22.7 p.s.i. for Machine C to a maximum of 29.3 p.s.i. for Machine J. The current F.K.I. average was 26.2 p.s.i., a little below the cumulative F.K.I. average of 27.4 as indicated by the F.K.I. index of 95.4%.

Machine J had the highest single-face flat crush value of 36.2 p.s.i. and Machine C had the lowest value, 25.4 p.s.i. The current F.K.I. average for flat crush was 32.4 p.s.i. and the cumulative F.K.I. average was 33.0 giving an F.K.I. index of 98.1%.

TABLE III

SUMMARY OF TEST RESULTS FOR MACHINE A

November, 1955

Code	Date Made	Date Recd.	Mill Roll No.	Type of Medium	Basis Weight, lb. per 1000 sq. ft.	Caliper, points	Concora Medium Test, p.s.i.	Single-Face Flat Crush, p.s.i.	Runability
A-1	11- 1-55	11- 7-55	1	Kraft	27.9	10.7	26.4	31.2	Satisfactory at 450 f.p.m.
A-2	11- 2-55	11- 7-55	2	Kraft	28.6	10.1	25.5	29.5	Satisfactory at 450 f.p.m.
A-3	11- 8-55	11-14-55	3	Kraft	27.5	10.0	25.3	29.7	Satisfactory at 450 f.p.m.
A-4	11- 9-55	11-14-55	4	Kraft	27.9	10.6	19.2	20.5	Satisfactory at 450 f.p.m.
A-5	11-14-55	11-25-55	5	Kraft	26.8	9.9	21.4	26.3	Satisfactory at 450 f.p.m.
Current Machine Average:					27.7	10.3	23.6	27.4	
Cumulative Machine Average					--	--	--	--	
Machine Factor, %					--	--	--	--	
Machine Index, %					104.4	98.7	85.9	83.1	

TABLE IV

SUMMARY OF TEST RESULTS FOR MACHINE B

November, 1955

Code	Date Made	Date Recd.	Mill Roll No.	Type of Medium	Basis Weight, lb. per 1000 sq. ft.	Caliper, points	Concora Medium Test, p.s.i.	Single-Face Flat Crush, p.s.i.	Runability
B-1	10-25.55	10-28-55	7	Semichemical	26.4	10.8	26.2	30.5	Satisfactory at 450 f.p.m.
B-2	10-27-55	10-31-55	8	Semichemical	26.0	10.7	26.7	33.4	Satisfactory at 450 f.p.m.
B-3	11- 1-55	11- 7-55	9	Semichemical	26.6	10.3	27.0	34.8	Satisfactory at 450 f.p.m.
B-4	11- 3-55	11- 7-55	10	Semichemical	26.8	10.5	26.7	30.9	Satisfactory at 450 f.p.m.
B-5	11- 8-55	11-14-55	11	Semichemical	27.4	10.7	27.8	34.0	Satisfactory at 450 f.p.m.
B-6	11-10-55	11-14-55	12	Semichemical	25.8	10.1	26.8	32.8	Satisfactory at 450 f.p.m.
B-7	11-16-55	11-21-55	13	Semichemical	26.4	10.2	26.8	31.8	Satisfactory at 450 f.p.m.
B-8	11-17-55	11-21-55	14	Semichemical	27.4	10.3	28.0	32.8	Satisfactory at 450 f.p.m.
Current Machine Average:					26.6	10.4	27.0	32.6	
Cumulative Machine Average:					26.6	10.8	28.3	32.5	
Machine Factor, %					100.0	97.0	95.5	100.3	
Machine Index, %					100.1	100.4	98.4	98.8	

TABLE V

SUMMARY OF TEST RESULTS FOR MACHINE C

November, 1955

Code	Date Made	Date Recd.	Mill Roll No.	Type of Medium	Basis Weight, lb. per 1000 sq. ft.	Caliper, points	Concora Medium Test, p.s.i.	Single-Face Flat Crush, p.s.i.	Runability
C-1	11-14-55	11-25-55	6	Kraft	28.3	11.0	22.7	25.4	Satisfactory at 450 f.p.m.
Current Machine Average:					28.3	11.0	22.7	25.4	
Cumulative Machine Average					--	--	--	--	
Machine Factor, %					--	--	--	--	
Machine Index, %					106.6	106.0	82.8	76.8	

TABLE VI

SUMMARY OF TEST RESULTS FOR MACHINE D*

November, 1955

D-1	11-21-55	11-25-55	1	Bogus	27.5	10.6	24.5	31.5	Satisfactory at 450 f.p.m.
Current Machine Average:					27.5	10.6	24.5	31.5	
Cumulative Machine Average					--	--	--	--	
Machine Factor, %					--	--	--	--	
Machine Index, %					103.5	101.9	89.4	95.3	

* No machine identity was given for the sample submitted.

TABLE VII

SUMMARY OF TEST RESULTS FOR MACHINE E
November, 1955

Code	Date Made	Date Recd.	Mill Roll No.	Type of Medium	Basis Weight, lb. per 1000 sq. ft.	Caliper, points	Concora Medium Test p.s.i.	Single-Face Flat Crush, p.s.i.	Runability
E-1	10-27-55	10-31-55	1	Semichemical	26.1	9.4	24.9	32.4	Satisfactory at 450 f.p.m.
Current Machine Average					26.1	9.4	24.9	32.4	
Cumulative Machine Average					--	--	--	--	
Machine Factor, %					--	--	--	--	
Machine Index, %					98.3	90.6	90.6	98.1	

TABLE VIII

SUMMARY OF TEST RESULTS FOR MACHINE F
November, 1955

F-1	10-26-55	11-4-55	85		27.3	10.3	27.0	34.9	Satisfactory at 450 f.p.m.
F-2	10-26-55	11-7-55	--		27.2	10.2	25.9	34.8	Satisfactory at 450 f.p.m.
Current Machine Average:					27.3	10.2	26.4	34.8	
Cumulative Machine Average					27.1	10.1	31.1	35.0	
Machine Factor, %					100.5	100.8	85.0	99.5	
Machine Index, %					102.6	98.2	96.5	105.5	

TABLE IX

SUMMARY OF TEST RESULTS FOR MACHINE G
November, 1955

Code	Date Made	Date Recd.	Mill Roll No.	Type of Medium	Basis Weight, lb. per 1000 sq. ft.	Caliper, points	Concora Medium Test, p.s.i.	Single-Face Flat Crush, p.s.i.	Runability
G-1	11-1-55	11-8-55	2	Semichemical	26.0	11.4	28.0	35.2	Satisfactory at 450 f.p.m.
Current Machine Average					26.0	11.4	28.0	35.2	
Cumulative Machine Average					--	--	--	--	
Machine Factor, %					--	--	--	--	
Machine Index, %					97.9	109.5	102.0	106.5	

TABLE X

SUMMARY OF TEST RESULTS FOR MACHINE H
November, 1955

Code	Date Made	Date Recd.	Mill Roll No.	Type of Medium	Basis Weight, lb. per 1000 sq. ft.	Caliper, points	Concora Medium Test, p.s.i.	Single-Face Flat Crush, p.s.i.	Runability
H-1	10-25-55	10-28-55	7	Semichemical	26.1	10.4	23.6	30.8	Satisfactory at 450 f.p.m.
H-2	10-27-55	10-31-55	8	Semichemical	25.8	10.2	26.5	30.3	Satisfactory at 450 f.p.m.
H-3	11- 1-55	11- 4-55	9	Semichemical	26.4	10.5	25.3	31.4	Satisfactory at 450 f.p.m.
H-4	11- 4-55	11- 7-55	10	Semichemical	26.3	11.5	26.3	31.3	Satisfactory at 450 f.p.m.
H-5	11- 8-55	11-14-55	11	Semichemical	26.5	10.3	26.9	32.3	Satisfactory at 450 f.p.m.
H-6	11-10-55	11-14-55	12	Semichemical	25.8	10.1	27.3	31.8	Satisfactory at 450 f.p.m.
H-7	11-15-35	11-18-55	13	Semichemical	25.7	10.2	24.6	30.5	Satisfactory at 450 f.p.m.
H-8	11-17-55	11-21-55	14	Semichemical	26.5	10.2	26.8	30.2	Satisfactory at 450 f.p.m.
Current Machine Average:					26.1	10.4	25.9	31.1	
Cumulative Machine Average					26. 3	10.4	26.5	30.7	
Machine Factor, %					99.3	100.0	97.8	101.3	
Machine Index, %					98.4	100.3	94.5	94.1	

TABLE XI

SUMMARY OF TEST RESULTS FOR MACHINE I
November, 1955

Code	Date Made	Date Recd.	Mill Roll No.	Type of Medium	Basis Weight, lb. per 1000 sq. ft.	Caliper, points	Concora Medium Test p.s.i.	Single-Face Flat Crush, p.s.i.	Runability
I-1	10-10-55	10-31-55	5	Semichemical	27.3	10.2	28.1	37.8	Satisfactory at 450 f.p.m.
I-2	10-27-55	11--3-55	6	Semichemical	27.2	10.4	28.5	36.0	Satisfactory at 450 f.p.m.
I-3	11-2-55	11- 7-55	7	Semichemical	27.3	10.4	26.0	34.4	Satisfactory at 450 f.p.m.
I-4	11-3-55	11--8-55	8	Semichemical	27.3	10.0	25.3	31.2	Satisfactory at 450 f.p.m.
I-5	11- 8-55	11-14-55	9	Semichemical	26.1	9.8	29.4	38.6	Satisfactory at 450 f.p.m.
I-6	11-11-55	11-18-55	10	Semichemical	27.0	9.9	31.1	38.1	Satisfactory at 450 f.p.m.
I-7	11-17-55	11-21-55	12	Semichemical	25.5	9.6	25.5	30.2	Satisfactory at 450 f.p.m.
Current Machine Average					26.8	10.0	27.7	35.2	
Cumulative Machine Average					26.8	10.2	27.2	34.2	
Machine Factor, %					100.0	98.1	101.7	103.0	
Machine Index, %					101.0	96.5	101.0	106.6	

TABLE XII

SUMMARY OF TEST RESULTS FOR MACHINE J

November, 1955

Code	Date Made	Date Recd.	Mill Roll No.	Type of Medium	Basis Weight, lb. per 1000 sq. ft.	Caliper, points	Concora Medium Test p.s.i.	Single-Face Flat Crush, p.s.i.	Runability
J-1	11-16-55	11-22-55	1	Semichemical	25.7	10.1	28.5	36.0	Satisfactory at 450 f.p.m.
J-2	11-17-55	11-22-55	2	Semichemical	28.5	10.8	30.1	36.4	Satisfactory at 450 f.p.m.
Current Machine Average:					27.1	10.4	29.3	36.2	
Cumulative Machine Average					--	--	--	--	
Machine Factor, %					--	--	--	--	
Machine Index, %					102.1	100.3	106.9	109.7	

TABLE XIII

SUMMARY OF TEST RESULTS FOR MACHINE K

November, 1955

Code	Date Made	Date Recd.	Mill Roll No.	Type of Medium	Basis Weight, lb. per 1000 sq. ft.	Caliper, points	Concora, Medium Test, p.s.i.	Single-Face Flat Crush, p.s.i.	Runability
K-1	10-25-55	10-31-55	14	Semichemical	26.4	11.3	23.7	29.5	Satisfactory at 450 f.p.m.
K-2	10-28-55	11- 3-55	16	Semichemical	26.0	11.3	24.7	29.0	Satisfactory at 450 f.p.m.
K-3	11- 1-55	11- 7-55	18	Semichemical	26.5	11.3	24.1	29.6	Satisfactory at 450 f.p.m.
K-4	11- 4-55	11- 8-55	20	Semichemical	25.5	10.8	24.0	29.7	Satisfactory at 450 f.p.m.
K-5	11- 8-55	11-14-55	22	Semichemical	25.8	10.7	28.0	31.4	Satisfactory at 450 f.p.m.
K-6	11-11-55	11-16-55	24	Semichemical	27.1	10.6	27.6	34.0	Satisfactory at 450 f.p.m.
K-7	11-15-55	11--21-55	26	Semichemical	26.3	10.9	24.5	32.5	Satisfactory at 450 f.p.m.
K-8	11-19-55	11-25-55	28	Semichemical	27.7	11.1	26.3	33.2	Satisfactory at 450 f.p.m.
Current Machine Average:					26.4	11.0	25.4	31.1	
Cumulative Machine Average:					26.1	11.0	24.1	31.0	
Machine Factor, %					101.2	100.0	105.3	100.4	
Machine Index, %					99.3	105.8	92.5	94.2	

TABLE XIV

SUMMARY OF TEST RESULTS FOR MACHINE L
November, 1955

Code	Date Made	Date Recd.	Mill Roll No.	Type of Medium	Basis Weight, lb. per 1000 sq. ft.	Caliper, points	Concora Medium Test, p.s.i.	Single-Face Flat Crush, p.s.i.	Runability
L-1	10-27-55	10-31-55	6	Semichemical	26.1	9.0	24.9	34.2	Satisfactory at 450 f.p.m.
L-2	10-27-55	11- 3-55	7	Semichemical	26.4	9.1	27.4	33.2	Satisfactory at 450 f.p.m.
L-3	11- 4-55	11-10-55	8	Semichemical	27.1	9.4	26.3	31.8	Satisfactory at 450 f.p.m.
L-4	11-10-55	11-14-55	9	Semichemical	25.2	9.3	24.5	32.1	Satisfactory at 450 f.p.m.
L-5	11-12-55	11-17-55	10	Semichemical	26.0	9.6	25.6	31.0	Satisfactory at 450 f.p.m.
L-6	11-16-55	11-21-55	11	Semichemical	25.8	9.6	24.4	32.2	Satisfactory at 450 f.p.m.
L-7	11-18-55	11-25-55	--	Semichemical	26.3	9.4	28.2	35.2	Satisfactory at 450 f.p.m.
L-8	11-20-55	11-25-55	12	Semichemical	27.4	9.7	26.4	32.2	Satisfactory at 450 f.p.m.
Current Machine Average:					26.3	9.4	25.9	32.7	
Cumulative Machine Average:					26.3	9.3	26.2	32.5	
Machine Factor, %					100.0	100.7	99.0	100.6	
Machine Index, %					99.0	90.3	94.6	99.1	

TABLE XV

SUMMARY OF TEST RESULTS FOR MACHINE M
November, 1955

Code	Date Made	Date Recd.	Mill Roll No.	Type of Medium	Basis Weight, lb. per 1000 sq. ft.	Caliper, points	Concora Medium Test, p.s.i.	Single-Face Flat Crush, p.s.i.	Durability
M-1	10-25-55	10-31-55	13	Semichemical	26.2	10.5	28.1	36.3	Satisfactory at 450 f.p.m.
M-2	10-28-55	11- 3-55	15	Semichemical	25.4	10.2	31.1	40.0	Satisfactory at 450 f.p.m.
M-3	11- 1-55	11- 7-55	17	Semichemical	27.4	11.2	29.2	35.0	Satisfactory at 450 f.p.m.
M-4	11- 4-55	11- 8-55	19	Semichemical	26.0	10.5	28.0	37.0	Satisfactory at 450 f.p.m.
M-5	11- 8-55	11-14-55	21	Semichemical	26.8	10.2	30.1	38.2	Satisfactory at 450 f.p.m.
M-6	11-11-55	11-16-55	23	Semichemical	27.7	11.0	29.3	36.6	Satisfactory at 450 f.p.m.
M-7	11-15-55	11-21-55	25	Semichemical	26.6	10.4	25.9	32.2	Satisfactory at 450 f.p.m.
M-8	11-19-55	11-25-55	27	Semichemical	26.2	11.0	27.9	30.2	Satisfactory at 450 f.p.m.
Current Machine Average:					26.5	10.7	28.7	35.7	
Cumulative Machine Average:					26.8	10.9	28.5	35.3	
Machine Factor, %					99.0	97.7	100.7	101.2	
Machine Index, %					99.8	102.5	104.7	108.1	